

CLAIMS

What is claimed is:

1. In a cochlear implant system having multiple electrode contacts through which electrical stimuli are adapted to be applied to a patient's inner ear, a method of generating stimulation parameters for use by the cochlear implant system, comprising:
 - generating electrical stimuli with selectable degrees of amplitude intensity;
 - delivering the electrical stimuli to selected groups of electrode contacts while gradually adjusting the intensity of the electrical stimuli and while monitoring at least one electrode contact near the group of electrode contacts receiving the delivered electrical stimuli for the occurrence of an evoked compound action potential (ECAP);
 - determining an electrical-stimuli intensity threshold level (tNRI) associated with the occurrence of the ECAP for each selected group of electrode contacts, the tNRI threshold level for all of the selected groups comprising tNRI threshold data;
 - processing the tNRI threshold data to determine a contour of tNRI threshold levels that defines a tNRI threshold for each electrode contact; and
 - using the contour of tNRI threshold levels to define stimulation parameters thereafter used by the cochlear implant system to control the intensity of the electrical stimuli applied through the electrode contacts.
2. The method of Claim 1 wherein the step for delivering the electrical stimuli to a selected group of electrode contacts comprises simultaneously delivering the electrical stimuli to each electrode contact within the selected group of electrode contacts.
4. The method of Claim 1 wherein the step for delivering the electrical stimuli to a selected group of electrode contacts comprises sequentially delivering the

electrical stimuli at a fast rate to the electrode contacts within the selected group of electrode contacts.

5. The method of Claim 1 wherein the step for determining an electrical-stimuli intensity threshold level (tNRI) associated with the occurrence of the ECAP for each selected group of electrode contacts comprises measuring the magnitude of the ECAP corresponding to a plurality of electrical-stimuli intensity levels, thereby creating a data set of ECAP magnitudes with corresponding electrical-stimuli intensity levels, and determining from the resulting data set an appropriate threshold level.

6. The method of Claim 5 wherein determining an appropriate threshold level from the data set comprises making a plot of ECAP magnitude verses electrical-stimuli intensity levels, and interpolating the plot, as required, to determine an appropriate tNRI threshold level for the selected group of electrodes.

7. The method of Claim 1 wherein processing the tNRI threshold data to determine a contour of tNRI threshold levels that defines a tNRI threshold for each electrode contact comprises combining the tNRI threshold level data from each selected group of electrodes and smoothing discontinuities therein.

8. The method of Claim 7 wherein smoothing discontinuities in the tNRI threshold data comprises applying a three-point weighted average, with the first and last data points of a three-consecutive data points being weighted a first prescribed percentage, and with the middle data point being weighted a second prescribed percentage, where the second prescribed percentage is greater than the first prescribed percentage.

9. The method of Claim 7 wherein smoothing discontinuities in the tNRI threshold data comprises applying a b-spline interpolation technique to the data.

10. The method of Claim 7 wherein smoothing discontinuities in the tNRI threshold data comprises applying a curve-smoothing algorithm to the tNRI threshold data.

11. A method for setting stimulation parameters used in a cochlear implant system, the cochlear implant system having a multiplicity of electrode contacts and means for delivering electrical stimuli to a selected electrode contact or a selected group of electrode contacts, the method comprising steps for:

- (a) defining a first group of electrode contacts;
- (b) defining an initial stimulation level;
- (c) simultaneously applying electrical stimuli at the defined stimulation level to the defined group of electrode contacts;
- (d) determining whether an evoked compound action potential (ECAP) is observed on an electrode contact near the defined group of electrode contacts, and if not, adjusting the defined stimulation level and repeating step (c);
- (e) recording the magnitude of the ECAP and the corresponding stimulation level;
- (f) determining whether sufficient ECAP data has been obtained, and if not, adjusting the defined stimulation level and repeating steps (c) through (e);
- (g) determining an appropriate NRI threshold (tNRI) for the defined electrode group of electrode contacts;
- (h) determining whether all desired groups of electrode contacts have been evaluated to determine a tNRI threshold, and if not, defining a next group of electrode contacts and repeating steps (b) through (g);
- (i) processing the tNRI threshold for each group of electrode contacts to obtain tNRI thresholds for each individual electrode contact; and
- (j) using the processed tNRI thresholds as a guide for setting stimulation parameters of the cochlear implant system.

12. The method of Claim 11 wherein step (e) comprises measuring the peak-to-peak amplitude of the ECAP from ECAP peak N1 to ECAP peak P2.

13. The method of Claim 12 wherein step (f) comprises determining whether at least three ECAP measurements have been made for the selected group of electrode contacts, each measurement being made at a different stimulation level.

14. The method of Claim 13 wherein step (g) comprises plotting the at least three ECAP measurements as a function of stimulation level and extrapolating the plot to determine a desired stimulation level (tNRI) for the selected group of electrode contacts.

15. The method of Claim 14 wherein step (l) comprises plotting the group tNRI threshold as a function of electrode group position and smoothing any discontinuities in the plotted tNRI thresholds, thereby creating a smoothed curve of tNRI data as a function of electrode position.

16. A cochlear implant system comprising:
multiple electrode contacts through which electrical stimuli are adapted to be applied to a patient's inner ear;
means for generating electrical stimuli with selectable degrees of amplitude intensity;
means for delivering the electrical stimuli to selected groups of electrode contacts while gradually adjusting the intensity of the electrical stimuli and while monitoring at least one electrode contact near the group of electrode contacts receiving the delivered electrical stimuli for the occurrence of an evoked compound action potential (ECAP);
means for determining an electrical-stimuli intensity threshold level (tNRI) associated with the occurrence of the ECAP for each selected group of electrode contacts, the tNRI threshold level for all of the selected groups comprising tNRI threshold data;
means for processing the tNRI threshold data to determine a contour of tNRI threshold levels that defines a tNRI threshold for each electrode contact; and

means for using the contour of tNRI threshold levels to define stimulation parameters thereafter used by the cochlear implant system to control the intensity of the electrical stimuli applied through the electrode contacts.

17. The system of Claim 16 wherein the means for delivering the electrical stimuli to a selected group of electrode contacts comprises means for simultaneously delivering the electrical stimuli to each electrode contact within the selected group of electrode contacts.

18. The system of Claim 16 wherein the means for delivering the electrical stimuli to a selected group of electrode contacts comprises means for sequentially delivering the electrical stimuli at a fast rate to the electrode contacts within the selected group of electrode contacts.

19. The system of Claim 16 wherein the means for determining an electrical-stimuli intensity threshold level (tNRI) associated with the occurrence of the ECAP for each selected group of electrode contacts comprises means for measuring the magnitude of the ECAP corresponding to a plurality of electrical-stimuli intensity levels, thereby creating a data set of ECAP magnitudes with corresponding electrical-stimuli intensity levels, and means for determining from the resulting data set an appropriate threshold level.